

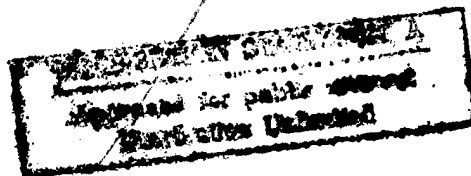
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18 September 1984

# China Report

SCIENCE AND TECHNOLOGY



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# CHINA REPORT

## SCIENCE AND TECHNOLOGY

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## APPLIED SCIENCES

### REMOTE SENSING TECHNOLOGY NOW PLAYING PRACTICAL ROLES

Beijing DIANZI SHIJIE [ELECTRONIC WORLD] in Chinese No 5, 1983 pp 4-5

[Article: "Applications of Remote Sensing Technology in China"]

[Text] Despite its rather late start, remote sensing technology is undergoing rapid development in China. China has launched and recovered numerous scientific research satellites and has successfully developed many types of aerial remote sensors, including the highly sophisticated multiband scanner and synthetic aperture lateral view radar. Rather high levels of development in designing and test producing optical image processors have been attained and the prospects of digital image processors being incorporated and assimilated in this area are promising. Many provinces, municipalities, and regions have been successful in experimenting with aerial remote sensing and satellite imagery analysis. In summing up the progress in recent years, it may be said that China is now beyond the assimilation and applied demonstration stages. Having gained first-hand experience, China is now forming a formidable corps of scientists and technicians, and by tackling key problems as a group, practical contributions toward the realization of the Sixth 5-Year Plan will be possible.

The initial progress in developing remote sensing which China has made in recent years, may be summarized in the following three areas:

#### I. Remote Sensing in Agriculture

Agriculture is the largest user and benefits in many ways from remote sensing. China is using remote sensing technology to survey geological and biological resources in order to facilitate soil surveying and apportionment of agricultural lands.

Aerial photography has been used to survey geological resource reference points in over 10 cities and counties, such as (in order of sequence): Tengchong, Taoyuan, Taihe, Hailun and Tianjin. Using the northern suburbs of Tianjin as an example, 28 areas were categorized into three levels. Accuracy of interpretation was as high as 98 percent. The error rate of using imagery maps to measure ground area was less than 1/400. When compared to data from actual surveys, the statistical results of the regression equation, when applied to ditches and roads, had an error ratio of less than 1/100. Therefore, it can be said that although there might be discrepancies between the

data and statistical tables, some as high as 15 to 30 percent, a basis for reference does exist, and it is possible to trace and check the changes of land use since the 1950's. Local governments appreciate the use of aerial photography in agricultural planning.

Nearly half of China's counties and cities have started in on China's second soil survey. In Tengchong, where data from aerial remote sensing was utilized, processing time, when compared to conventional methods, was stepped up three to five times. Error rate of boundary lines, based on aerial interpretation, was 5 to 8 percent, which is merely one-third to one-fourth of conventional methods. In Handan, capital investment for compiling a 1:200,000 scale soil and ground resource map by using satellite photography, was 3 to 5 percent of conventional methods. This project took less than half a year to complete.

In sectionalizing the entire province of Shanxi, 17 specialized 1:250,000 maps of the province's 150,000 km<sup>2</sup> area were completed in less than a year. Starting with satellite imagery interpretation, information gained from aerial methods and ground verification was then later added. Specialized analysis in agricultural geology, water shed structure, and analysis of hydrological subsidence surfaces has allowed for the production of maps previously never produced. The accuracy of mapping water systems, terrain, and forest distribution, as well as the classifying of grasslands and present land use, was also greatly improved. Ditches with lengths greater than 1 km, small and large reservoirs with surface areas greater than 0.0625 km<sup>2</sup>, agricultural farmland greater than 93 mu, and populated areas of over 100 households were reflected in these maps. It took only 25 workers 1 year and 7 months to check the 20.03 million mu of wasteland resources in the western Huanghe corridor of Hexi by using satellite imagery. It would have taken 120 times the work force to do the same job through conventional means, thus remote sensing has cut down expenses by 98 percent. The use of satellite imagery for agricultural apportionment and exploration of wastelands has been appraised as being suitable for general use.

Significant economic benefits in estimating and forecasting biomass in the grasslands and forests have been gained. The accuracy of remote sensing surveys of Dongting Lake, Bosten (Bagrax) Lake, and the reed resources of Nei Mongol has been greater than 90 percent. This has provided timely and realistic data for the planning of papermaking and chemical fiber factories, reducing expenditures by 64 percent and increasing efficiency by nearly 100 percent. During the Sixth 5-Year Plan, the area of China's man-made grasslands will increase from 32 million to 100 million mu. Remote sensing monitoring will greatly facilitate efforts in estimating grazing capacity and the work of improving and managing grasslands. Estimating China's forest reserves by means of remote sensing began in the 1950's when aerial methods were already in use. Great improvements have been made in recent years in increasing the accuracy of drawing up a forest stand accumulation table. In 1977 using satellite imagery as a basis, remote sensing surveys were conducted on the Tibetan forest lands. The accumulation rate recorded was nine times greater than originally held data. During the Sixth 5-Year Plan, in order to raise the preservation rate to more than 60 percent by 1985, we plan to afforest 290 million mu of land nationwide, and regenerate 39.1 million mu of slash area. These operations will require the use of remote sensing monitoring in order to monitor these operations successfully.

As our system of agriculture is complex, and our farm plots small, the use of remote sensing to estimate production of paddy rice will be a very difficult problem. During the Sixth 5-Year Plan, the total area for food grain production in China has been set at 1.7 billion mu. The area planted in cotton has been set at about 85 million mu; also we want to control the area used for rapeseed and cured tobacco. How is this plan working? Through the use of remote sensing, it is entirely possible to stay on top of it.

## II. Remote Sensing of Resources and Energy Sources

The Sixth 5-Year Plan calls for stepping up the evaluation of mines and natural resources, do better work in comprehensive mineral prospecting, get a tight grasp on surveying and prospecting for energy resources, especially petroleum and natural gas, increase the amount of reserves available for development. Remote sensing serves as one means for prospecting. Its role in finding mineral resources is primarily seen in the following four technical areas:

1. Image Tracing and Analyzing Mineral Deposit Structures. After geologic charts are revised by remote sensing imagery, new knowledge of geological strata and structure can be gained. Prospective reserves can be expanded on the basis of fissure-intersecting sites. The boundary of intrusive bodies is often based on the distribution of endogenous metallic deposits, around which intrusive bodies are found. It is not difficult to identify the signs for locating pocket-shaped mineral beds from environmental image traces. There are many cases in south and southwest China where this can be verified.
2. Transmission of Hidden Information. For example, in the forest regions of northeast China, aerial photography was used to analyze the mineral traces of alluvial gold deposits to find veins of gold and silver of higher industrial quality by probing the diffusion halos along the river valleys of source areas, thereby increasing the reserves of alluvial gold and gold veins by the tons.
3. Remote Sensing and Botanical Indicators. For example, the relationship between shallow oil and natural gas reserves, geochemical anomalies of surface oil and photospectric anomalies of plant life has been studied in Nei Mongol to identify a means for finding shallow oil. Similar methods were used at Tengchong, Chaohu, and the Sanjiang Plain in determining the range of peat deposits.
4. Using "Information Recombination" Methods. Not only do multiple spectrums, lateral view radar and other remote imagery techniques compliment each other, but the recombining of gravitational anomalies, geomagnetic anomalies, seismic waves and other geophysical parameters must be considered. For example, in calculating the oil and natural gas fields in the northwest's inland basin, over 10 parameters were considered. Many ring-shaped images were discovered, and after some verification, it was determined that there were reasons to believe there might be oil reserves.

As bodies of water appear as a noticeable absorption peak in infrared and microwave bands, therefore many natural factors related to surface humidity and

water-air temperature difference, or continental hydrology and hydrological geology, may often directly affect remote sensing images, providing an abundance of information which can be used in prospecting for ground water and underground water resources. After analyzing the submerged water-borne conditions of Shanxi's Wenyu He and Shandong's Dawen He by means of satellite imagery and aerial photography, based on the balance of water levels and interaction in the closed river basin, and the conversion of precipitation to ground table runoff, the rate of error was less than 14.3 percent when compared to actual measured data. The shallow ground water and distribution of ancient waterways in the North China Plain were successfully studied by means of satellite imagery. Infrared aerial photography was also successfully used in Guangxi to check the subterranean water system of the Karst underground rivers. Among the 21 sites where there exists subterranean river dissolution and underwater intake along the Li Jiang between Guilin and Yangshuo, two locations were found where upwelling from the river bed occurred.

With regard to marine development, the Sixth 5-Year Plan has established the construction of 15 harbors. If continental satellite and meteorological satellite imagery are used comprehensively, then remote sensing could provide extremely difficult-to-obtain dynamic information. Silt dispersion outside the Huang He and Chang Jiang River estuaries, as well as the formation and shifting of northern Jiangsu's "Five Offshore Sandbanks," the effect of Huang He silt on the Xiaoqing He and other problems are very much related to harbor construction. Such information can now be routinely provided by satellite imagery, rendering valuable macroscopic patterns. The accuracy of satellite imagery-aided classification of coastal mudflats along the Bohai, Jiaozhou Bay, and Hangzhou Bay is greater than 85 percent. The ecological environment of Laizhou Bay's underwater topology and commercial shellfish was analyzed by means of satellite imagery surveillance grouping and classification. The production potential of *Arca granosa* (ark shells), hard clams, and *Cipangopaludina chinensis* has been estimated. Classification of the Zhu Jiang delta was based on the ratio of Sankey fishpond chlorophyll content to water and land area. This opens up new paths for preliminary estimation of production capacities. Similar work involving various water areas and shoreline mudflats, such as lakes, small and large reservoirs, will ensure the realization of the expansion of fresh water aquatic breeding area by 59 million mu and marine fish breeding area by 2.5 million mu in 1985. This will be of great help.

### III. Remote Sensing in Environmental Engineering

The Sixth 5-Year Plan calls for the cessation of the destruction of the natural environment and the prevention of the development of pollution. It calls for efforts to be made in controlling the continuous deterioration of the ecological environment as well as improving the environmental conditions of several scenic tourist cities. In recent years, China has conducted many aerial remote sensing experiments, performing background analysis and evaluating the environmental quality and degree of pollution in such cities as Shenyang, Changchun, Taiyuan, Dalian, Qingdao and Tianjin. These experiments have included remote sensing monitoring of metropolitan thermal islands, smog diffusion, pollution of water sources, greenery indexes and vehicular traffic flow. Initial results have been achieved. Yasunori Nakayama and others from Japan have used Landsat data to analyze forests, park lands, and agricultural



and populated areas of nine Chinese cities. Their evaluation of the environmental quality of these cities has been published. After comparing 32 large metropolitan areas in Asia, America and Europe, it was found that the green areas of Shanghai and Tianjin were noticeably low. Moreover, remote sensor monitoring can be used to estimate the growth rate of trees suitable for cultivation, estimating vehicular traffic flow, selecting mineral dump sites for waste sludge, and expanding the base area for growing vegetables. Data storage for information systems and machine-aided mapping software systems have also been designed for environmental engineering, serving municipal construction.

Remote sensing has even greater significance in energy resources and preliminary engineering projects in transportation construction. Satellite imagery has found rather ideal safety islands for locating electric power plants and bridges, avoiding the dangers of active faults. In recent years, the threat of landslides and mud flows over railways, transportation routes and reservoir structures in the mountain areas surrounding the Sichuan basin has been great. Not only are construction projects affected, but the dangers of hidden catastrophes are tremendous. This is because railway lines or dam sites were often built in deep and narrow valleys running along fracture and fragment belts. There has often been a lack of complete investigative research into such harmful geologic phenomena along railway lines or in dam areas. In order to cut down on capital investment for engineering and investigation of hidden dangers, remote sensing has been used to detect the distribution of frozen earth along the Qinghai-Tibet Highway, the advance and retraction of the Batura Glacier along the China-Pakistan Highway, and in the construction of the Dayao Shan tunnel project along the Beijing-Guangzhou railway. Experiments have shown that remote sensor estimates of submersion loss during preliminary phases of reservoir construction has had an error factor of less than 1 percent. The accuracy of remote sensing interpretation of mud and rock slides has been as high as 90 percent. Provisions have been made in the Sixth 5-Year Plan for a number of medium-size hydroelectric stations to be located near load centers, with low submersion loss, low investment, and visible effects. The seven newly constructed and reconstructed highway throughfares, including the Qinghai-Tibet and the Tanzanian Highway will be able to completely utilize remote sensing technology to overcome natural obstructions, thereby raising the efficiency and scope of prospecting plans. With regard to the China-Nepal Highway and the Tanzania Railway which China is helping to build, the quality of construction has been evaluated and checked internationally by means of remote sensing.

The scope of applied remote sensing in environmental monitoring and natural protection is especially broad. Infrared monitoring of forest fires was used very early by the forestry sector. Friendly countries have used satellites to provide China with disaster reports on the Lancang Jiang forest fire in Yunnan and damage reports of the icing of the upper reaches of the Keriya River in Xinjiang. Fourteen days after the pinemoth (*dendrolimus*) appeared, signs of this disaster were reflected in infrared remote sensing imagery. The periodicity of remote sensing data can be used in active monitoring and in upgrading scientific management of logging forest timber, maintaining the rate of reafforested areas, general surveying of drought, flood and earthquake areas, irrigation effectiveness and desert encroachment and salinization, as

well as the forecasting of crop pestilence, loss of municipal energy sources and seepage of subterranean petroleum and gas pipelines. After China established its Landsat earth receiving station in 1984, dynamic remote sensing monitored data will be provided for comprehensive and essential problem areas, such as the unlawful felling of forest timber, water erosion, soil erosion and river flooding.

12544

CSO: 4008/70

## APPLIED SCIENCES

### SYSTEMS ENGINEERING SOCIETY ANNUAL CONFERENCE

Beijing XITONG GONGCHENG LILUN YU SHIJIAN [THEORY AND PRACTICE OF SYSTEMS ENGINEERING] in Chinese No 1, 1984 pp 65-66

[Article: "Third Annual Conference of the China Systems Engineering Society Held in Wuchang"]

[Text] Under the sponsorship of the Wuhan Military District, the Hubei provincial council, the Wuhan City council, the Hubei Scientific Association, the Wuhan Scientific Association, the Huazhong Engineering College Party Committee, and the Wuhan Office of Mathematical Physics of the Chinese Academy of Sciences, and with the dedicated efforts of the leaders and working members of the society, the third annual conference of the China Systems Engineering Society was held in Wuchang from November 21 to 27, 1983.

A total of 293 representatives from 18 provinces and cities and 166 different organizations attended this year's annual conference, in which more than 180 papers were presented. Twenty representatives presented major papers during the main conference, and nearly 100 presented papers in side sessions. This is an important indication that systems engineering is flourishing in this country.

Among the attendees of the opening and closing ceremonies were the commanders of the Wuhan Military District comrades Zhou Shizong, political committee member Yen Zheng, deputy commanders Li Guangjun and Hou Rentao, consultant Li Huamin, strategic officer of the Wuhan Military District Tang Jiao, deputy chairman of the provincial people's council Li Fuquan, secretary of the city council and mayor of Wuhan Wu Guanzheng, assistant head of the propaganda department of the provincial council Li Dehua, assistant secretary of the party committee of Wuhan University Chui Jianrui, director of the Wuhan Office of the Chinese Academy of Sciences professor Qian Baogong, deputy director Cheng Jie, consultant to the Provincial Council Qui Jingshan, and director of the Provincial Scientific Association Li Xing. These gentlemen also gave speeches during the conference.

The president of the Chinese Academy of Sciences Ma Hong presented a written report on "New Scenarios for Promoting of Systems Engineering Research."

In organizing this conference, the Wuhan Military District, the Hubei Provincial Council, the Hubei Scientific Association, and the Wuhan Scientific Association all gave their full support to ensure the success of the annual conference.

During the conference period, members of the working crew and comrades of the administrative office and hospitality house of the Military District labored day and night to ensure that the conference would proceed in an orderly manner without interruptions. To these people the delegates would like to express their sincere thanks.

The third annual conference was motivated by the spirit of the 12th Party Congress. China is fighting an ideological battle to clean up spiritual pollution, and its socialist modernization effort has entered into a new era of historical development. Moreover, the Chinese people are striving to achieve the goals of modernization as directed by the 12th Party Congress. This scenario presents an important and challenging mission for the systems engineer and also creates unprecedented favorable conditions for them.

The technical discussions of this conference were centered around reviewing and exchanging experiences and results in applying systems engineering to problems of national economic development and defense construction. Most of the 180 papers presented at the conference were based on actual applications of systems engineering in the fields of industrial and agricultural production, energy, transportation, hydroelectric power, mining, environmental protection, cultural and educational activities, population, human resource development, economic planning and management, and military affairs. In each field, outstanding results and higher standards have been achieved, and the number of systems engineers is growing rapidly; also, leaders at different levels are becoming increasingly aware of the importance of systems engineering. This shows that systems engineers are intimately involved with the interests of the Chinese people and the Communist Party.

Since the 2nd annual conference, the society sponsored 11 technical symposiums, established the Socioeconomic Systems Engineering Society, the Fuzzy Mathematics and Fuzzy Systems Society, and sponsored the 1983 Spring panel discussion. Systems engineering societies have also been established in Dalian City, in Dongshan City of Sichuan and at the Shanghai Petrochemical Factory. Since 1982, the Sian Systems Engineering Society has been actively promoting applied research and has sponsored more than 10 research projects in the areas of industry, commerce and agriculture. The provincial council and the provincial government also approved the establishment of the Shanxi Technology and Economic Consulting Company. Since the establishment of the technology consulting committee, the Hunan Systems Engineering Society has sponsored four research projects. The society has also sponsored six seminars which were attended by more than 470 students, and participated in the scientific exploration and consulting work in the remote regions of Xinjiang and Fujian organized by the Chinese Scientific Association.

In order to further develop the theoretical and practical work in systems engineering, three issues of the journal THEORY AND PRACTICE OF SYSTEMS ENGINEERING have been published; the number of copies has increased from 3,000 per year in 1981 to 8,500 this year. In September of this year, the Hunan Systems Engineering Society began publishing the magazine SYSTEMS ENGINEERING; in addition, 11 issues of the society's bulletin of conference proceedings have been published.

During the conference period, four working meetings--the board of directors meeting, the journal editorial committee meeting, the editorial and publication committee meeting, and the education working committee meeting--were held to discuss the following issues for next year:

1. The election of a board of directors. It was decided to elect the board of directors based on the spirit of the 3rd Congress of the Scientific Association. The election procedure will be as follows: a) each region and each organization will determine the number of election units based on individual progress in systems engineering; b) the election units will elect the representatives and candidates for the board of directors; c) the current board members will become the representatives and candidates; d) the proportional increase in the number of board members will be decided by the 3rd Congress of the Scientific Association.

To improve the election process, it was decided to establish an election working group which will report to the chairman of the board and the secretary in Beijing. The working group will consist of one comrade from each of the following units: the office of the secretary of the society headquarters, the special committee on socioeconomic systems engineering, the committee on military systems engineering, the committee on general systems theory, and the editorial office of the society journal. The election process will be accomplished by means of newsletter.

2. The "China in the 21st century" research project. The "China in the 21st Century" research project was initiated by the Chinese Scientific Association. Conference participants unanimously agreed that this project is so important that the society must make their contributions by assigning systems engineers to the projects, and must require each special committee to include this project as an important part of its charter. Because this work affects the future development of this country, we must insist on following the principles of Marxism and the ideology of Mao Zedong in order to properly apply the theories and techniques of systems engineering and other scientific disciplines; we must have a responsible attitude and a realistic scientific spirit; we must contribute our efforts to the cause of four modernizations by participating in consultations and forecasting.

In order to carry out this work effectively, it was decided to assign deputy secretary Chen Li to organize the 21st century systems engineering task force, and to assign a liaison person from the society headquarters as well as one from each special committee to be in charge of the actual organization and liaison work.

3. It was suggested by the board of directors to hold the next annual conference in Sian, and to request the Shanxi Technology and Economic Consulting Company and the Sian Systems Engineering Society to be the hosts for the conference. It was also decided to designate "China in the 21st century and systems engineering" as one of the main themes of the conference.

4. Representatives at the conference believed that it is essential to actively pursue the spiritual pollution clean-up operation as suggested by the central government. Currently, the research and application of systems engineering in China have expanded from engineering technology to other fields such as economy, as well as social and military sciences. Therefore, we must combine the basic principles of Marxism with the specific conditions in China when pursuing systems engineering research.

5. The following decisions were made by the editorial and publication committee: a) approve the revised list of names of the editorial committee of THEORY AND PRACTICE OF SYSTEMS ENGINEERING; b) publish a series of reference books in systems engineering for graduate students; c) suggest that Tianjing University be in charge of publishing BULLETIN OF SYSTEMS ENGINEERING.

The spirit of the society's organizational working conference sponsored by the Chinese Scientific Association in Zhengzhou was conveyed to board members at the board of directors meeting; the new party organization and expanded office of the secretary of the Chinese Scientific Association were also introduced to the board members. Other business topics were discussed.

Finally, the board of directors and conference participants paid their tribute and deep respect to the late chairman of the board, the famous Chinese mathematician, and also one of the active promoters of the society, comrade Zhao Zhi.

3012

CSO: 4008/317

REACTION OF UNSATURATED ORGANIC COMPOUNDS WITH TRITIUM GAS

Beijing HE HUAXUE YU FANGSHE HUAXUE [JOURNAL OF NUCLEAR AND RADIOCHEMISTRY] in Chinese Vol 4, No 4, Nov 82 pp 210-215

[Article by Ding Shaofeng\* [0002 4801 7364], Yi Mingquang\*\* [0308 2494 0342], Meng Zhaoxing\* [1322 2507 5281], Zheng Shijun\* [6774 0031 0971], and Zheng Rui\*\*\* [6774 3843]]

[Text] Abstract

The principal reaction sites of unsaturated organic compounds irisquinone and isopropiram fumarate with tritium gas were determined. The results show that the principal reaction was not electrophilic addition on the carbon-carbon double bond, instead, it was the tritium incorporated by electrophilic substitution attached to the carbon bonds. CNDO/2 calculations showed that the  $\pi$ -electron polarizability (superdelocalizability) of the reaction sites was greater than that of the carbon-carbon double bond.

(Key words--Tritium gas, Unsaturated organic compounds, Irisquinone, Isopropiram fumarate,  $\pi$ -electron polarizability)

I. Introduction

Wide attention in China and abroad has been given to the Wilzbach tritium irradiation method for labelling the reaction site of unsaturated organic compounds. Papers in foreign journals<sup>1,2</sup> claim that the reaction of tritium gas and unsaturated organic compound is principally an electrophilic addition on the isolated carbon-carbon double bond; no reports have been found in the Chinese literature. Whether the substituent in unsaturated organic compounds containing carbon-carbon double bond is an electron donating group or an electron withdrawing group has a certain effect on the activity of the double

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\*Department of Chemistry, Beijing Normal University

\*\*Institute of Atomic Energy

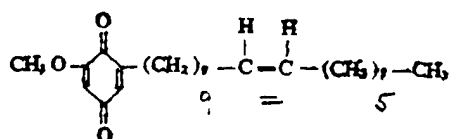
\*\*\*Tianjin Institute of Materia Medica

bond. In the reaction of tritium gas with unsaturated organic compounds with a carbon-carbon double bond, whether the reaction is an electrophilic addition on the double bond or an electrophilic substitution on some other site, or a combination of both, is a complex problem. Further investigations are needed both theoretically and experimentally.

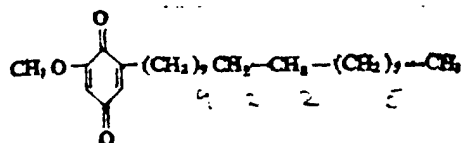
We studied the reaction of tritium gas with Chinese herbal medicine constituents irisquinone A, irisquinone B, isopropiram fumarate, and isopropiram succinate, compared the experimental results and carried out theoretical computations<sup>3,4</sup> for their respective molecular structures. The experimental results showed that the principal reaction site of irisquinone with tritium gas is the  $\alpha$ -site of the quinone ring. The principal reaction site of isopropiram fumarate with tritium gas is the isopropiram. The theoretical calculation and the experimental results are in agreement.

## II. Experimental Results

The molecular structure of irisquinone A is

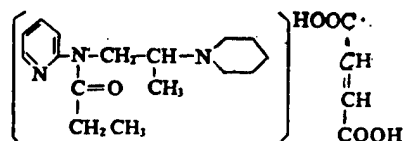


and the molecular structure of irisquinone B is



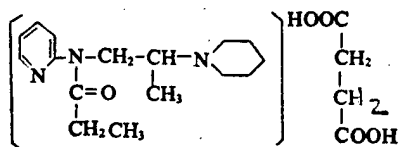
The only difference in the two molecular structures is that the side chain of irisquinone has a carbon-carbon double bond.

The molecular structure of isopropiram fumarate is





and the molecular structure of isopropiram succinate is



The molecular structures of isopropiram fumarate and isopropiram succinate are identical except the carbon-carbon double bond.

#### 1. Nonradioactive experiment

We accurately weighed 10 mg of irisquinone and uniformly spread it on the inner wall of the exposure bottle (Fig. 1A). The bottle was connected to a vacuum system, pumped down to  $2 \times 10^{-2}$  mm Hg and filled with 30 mm Hg of hydrogen gas. After 10 minutes of high-frequency discharge at room temperature each day for 7 days, the sample film was removed and purified. Measurement of the melting point and the  $R_f$  value showed no change.

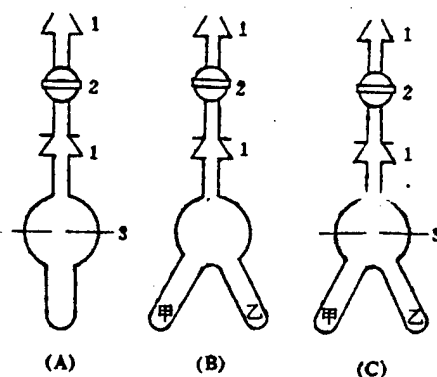
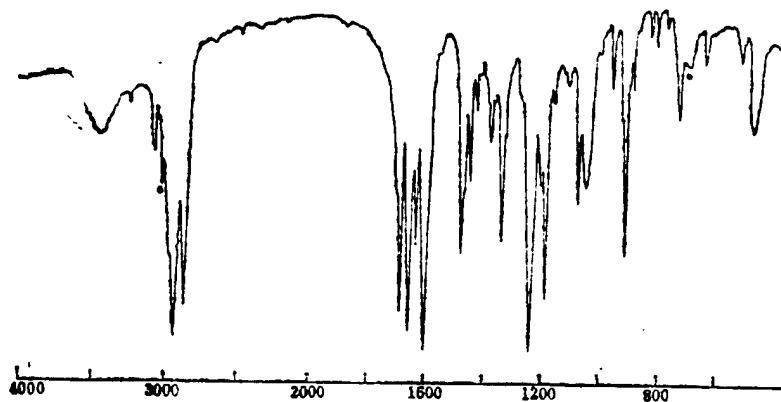


Fig. 1. Exposure bottles

1. Standard #10 male-female ground coupler
2. Vacuum valve
3. Tungsten rod

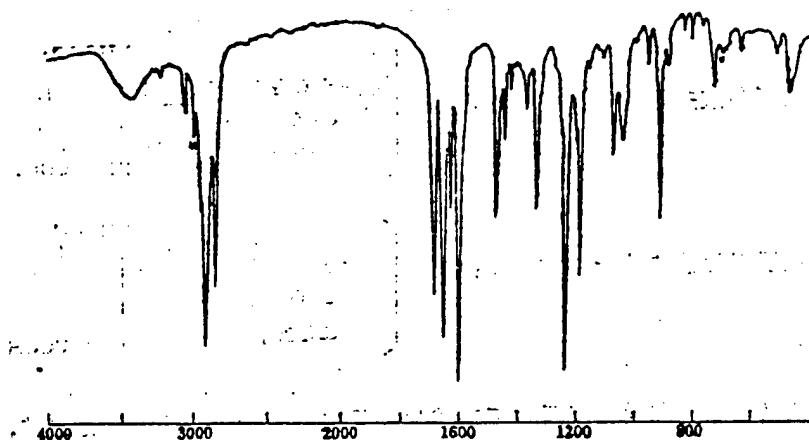
The infrared absorption spectrum of the sample (Fig. 2) was identical to that of the irisquinone standard (Fig. 3). Both spectra showed a weak side chain double bond absorption peak at wavenumbers 690 and 3010  $\text{cm}^{-1}$ . The infrared absorption spectrum of standard irisquinone B (Fig. 4) showed no absorption peak at these wavenumbers. The double bond on the side chain of irisquinone apparently did not change after high frequency discharge irradiation in hydrogen gas.



wavenumber  $\text{cm}^{-1}$

Fig. 2. Infrared absorption spectrum of irisquinone after hydrogen gas irradiation

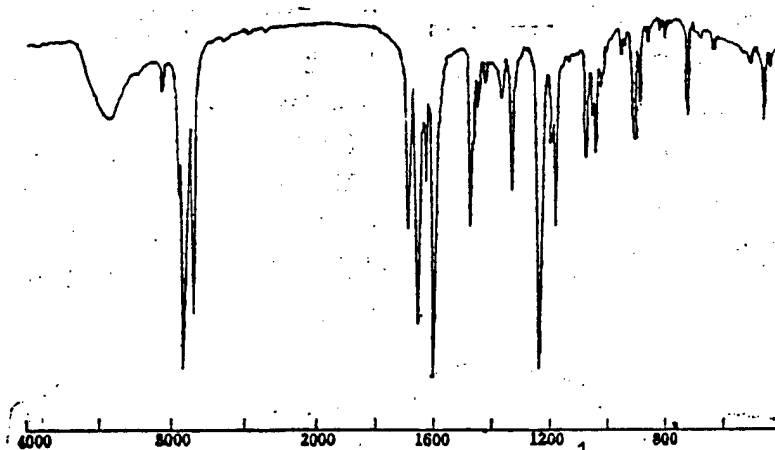
\*---double bond absorption peak



wavenumber  $\text{cm}^{-1}$

Fig. 3. Infrared absorption spectrum of irisquinone

\*---double bond absorption peak



wavenumber cm<sup>-1</sup>

Fig. 4. Infrared absorption spectrum of irisquinone B

## 2. Radioactive experiment

We accurately weighed irisquinone A and irisquinone B, and isopropiram fumarate and isopropiram succinate, and uniformly spread them on the inner walls of the two legs a and b of the bottles in Figs. 1(B) and 1(C). The bottles are connected to the vacuum system, pumped down to  $2 \times 10^{-2}$  mm Hg and filled with a certain amount of tritium gas. We let the samples compete in reacting with the tritium gas under the same condition with and without 10 minutes of high-frequency discharge per day at room temperature for several days. After irradiation, the samples are removed, purified and measured with a FJ-353 dual channel liquid scintillation counter and their radioactivities are compared. The experimental results are listed in Table 1.

## III. Theoretical calculation

We calculated the electric charge distribution, molecular orbits and energy levels of irisquinone and isopropiram fumarate using a semi-empirical self-consistent field method CNDO/2. Based on the computation results, we calculated the electron polarizability  $P_A$  of the  $\pi$  electron<sup>5</sup> with the following equation:

$$P_A = 2 \sum_i \frac{C_{is}^2}{-E_i}$$

Table 1 Competition reaction with tritium gas

Code	Reactants	Amount (mg)	High-frequency discharge	Exposure time (days)	Tritium gas pressure (mm Hg)	Radioactivity mCi/mM
1	Irisquinone A	10	+	21	15(1.5Ci)	6.00
		10				6.70
2	Irisquinone B	10	-	21	15(1.5Ci)	1.81
		10				1.91
3	Isopropiram fumarate	50	+	7	20(2Ci)	3.07
	Isopropiram succinate	50				3.25
4	Isopropiram fumarate	10	-	21	15(1.5Ci)	1.74
	Isopropiram succinate	10				2.11

Note: Reaction at room temperature

where  $C_i$  is the coefficient of the  $2p_z(\pi)$  atomic orbital of the s atom in the  $i$ th MO,  $E_i$  is the energy level of this MO and the summation is over all the occupied orbitals. The calculated electric charge distribution and the  $P_A^5$  value are listed in Tables 2 and 3.

Table 2 Charge distribution and  $\pi$  electron polarizability at  $\alpha_1$  and  $\alpha_2$  sites on the quinone ring and at  $C_1$  and  $C_2$  sites on the side chain double bond of irisquinone

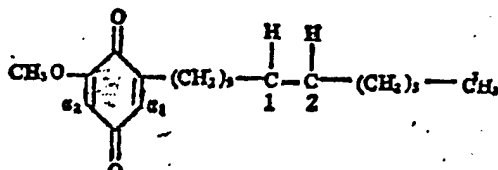
Molecular structure	site	Net charge	$\pi$ charge	$\pi$ electron polarizability $P_A$
	$\alpha_1$	-0.105	-0.0715	1.89
	$\alpha_2$	-0.0575	-0.0273	2.16
	$C_1$	-0.0141	-0.0129	1.80
	$C_2$	-0.0105	-0.0113	1.79

Table 3 Charge distribution and  $\pi$  electron polarizability at various sites of isopropiram fumarate

Molecular structure	site	Net charge	$\pi$ charge	$\pi$ electron polarizability $P_A$
	C <sub>3</sub>	-0.0581	-0.115	1.85
	C <sub>5</sub>	-0.0730	-0.0163	1.88
	C <sub>9</sub>	-0.0144	+0.0388	1.44
	C <sub>10</sub>	-0.381	-0.318	0.89
	C <sub>22</sub>	-0.375	+0.0491	1.72
	C <sub>23</sub>	-0.375	+0.0491	1.72

Note: Numbers on the molecular structure formula are codes for polarizability calculation

#### IV. Discussion

1. When irisquinone A and irisquinone B, and isopropiram fumarate and isopropiram succinate, are allowed to compete in their reaction with tritium gas under the same conditions, the radioactivities of the resulting  $^3\text{H}$ -irisquinone A and  $^3\text{H}$ -irisquinone B after purification are comparable. The radioactivities of the resulting  $^3\text{H}$ -isopropiram fumarate and  $^3\text{H}$ -isopropiram succinate are also approximately equal. The experiments showed that the principal reaction site of irisquinone and isopropiram fumarate with tritium gas are not the carbon-carbon double bond, instead, the reaction takes place at some other more active site. If the principal reaction site were the carbon-carbon double bond, then the radioactivity of tritium-labelled irisquinone and tritium-labelled isopropiram fumarate should have been much higher than tritium-labelled irisquinone B and tritium-labelled isopropiram succinate.

2. The reaction between tritium gas and organic compounds is electrophilic. The tritium gas produces  $\text{HeT}^+$  in its decay and  $\beta$ -labelled tritium<sup>2</sup> produces  $\text{T}_2^+$  and  $\text{T}_3^+$ . These positive ions act like electrophilic reagents and attack the most active sites in electrophilic substitution reaction and electrophilic addition reaction.

3. The intermediate body in the addition reaction between tritium and alkene is the noncyclic carbon positive ion. The controlling factor of the reaction rate is the  $\pi$  electron polarizability  $P_A$  of some unsaturated carbon atom. The localization effect of the electrophilic substitution reaction is not determined by the charge quantity at various places because the bonding of the electrophilic reagent and the aromatic hydrocarbon is not an electrostatic

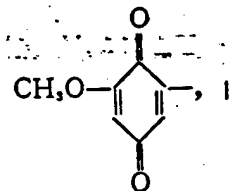
interaction but rather a valence interaction. In the electrophilic substitution reaction the determining step of the reaction rate is the formation of electron donating bonds between the electrophilic reagent and the aromatic ring. The formation of the electron donating bond is mainly determined by the ability of the aromatic ring to donate the  $\pi$  electron, that is, the  $\pi$  electron polarizability<sup>5</sup>  $P_A$ . When the tritium gas reacts with an organic compound, the reaction takes place mainly at the most active site. The  $\pi$  electron polarizability is a measure of the activity at various sites of the organic compound. Calculations show that, in the irisquinone molecule, the  $\alpha_1$  and  $\alpha_2$  sites are more active than the  $C_1$  and  $C_2$  sites. Therefore, the reaction with tritium gas is principally an electrophilic substitution reaction at the  $\alpha_1$  and  $\alpha_2$  sites of the quinone ring. Similarly, in a molecule of isopropiram fumarate, the  $C_3$  and  $C_5$  sites are more active than the  $C_{22}$  and  $C_{23}$  sites and, as a result, the tritium gas mainly reacts with the molecule at  $C_3$  and  $C_5$  sites of the quinone ring in an electrophilic substitution reaction.

4. The factor that controls the rate of an addition reaction in a nonconjugate alkene is the  $\pi$  electron polarizability  $P_A$  of a certain nonsaturated carbon atom. The R substituent of alkene has an effect on the rate of electrophilic addition and the effect is mainly in changing the  $P_A$  and  $P_B$  of alkene.  $P_B$  is the polarizability of the  $\pi$  bond electron cloud, it is the electron donating ability of the entire  $\pi$  electron cloud of the double bond and controls the formation of the positive ion intermediate body of the bridge ring.  $P_B$  is given by the following formula

$$P_B = \sum_n (C_{s_1}^2 + C_{s_2}^2) / E_n$$

where the summation is over all the occupied states.

The electron donating group increases the  $P_A$  and  $P_B$  of alkene and the electron withdrawing group decreases the  $P_A$  and  $P_B$  of alkene<sup>6</sup>. The  $\text{COOH}$  carboxyl group in the fumaric acid is an electron withdrawing group and decreases the  $P_A$ , and the activity, of the unsaturated carbon atom. The side chain of irisquinone is a straight chain alkene and the substituent is



Since the side chain is very long, the substituent does not have a very large effect on the  $P_A$  of the unsaturated carbon atom in the side chain. But the  $\alpha_1$  and  $\alpha_2$  sites of the quinone ring have high activity and therefore the principal reaction site of tritium with these two unsaturated organic compounds is not

the carbon-carbon double bond. In summary, whether the reaction between tritium and an unsaturated organic compound is electrophilic addition or electrophilic substitution mainly depends on the value of  $P_A$  and  $P_B$  at various sites.

The authors express their gratitude to Lin Aiqiu of the Chemistry Department of Beijing Normal University for taking the infrared absorption spectra.

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9698

CSO: 4008/34

## LIFE SCIENCES

### EVOLUTION OF MEDICAL EDUCATION IN CHINA

Beijing CHINESE MEDICAL JOURNAL in English No 6, Jun 84 pp 440-441

[Article by Cheng Zhi-fan, Department of Medical History, Beijing Medical College, Beijing: "Evolution of Medical Education in China"]

[Excerpt] Since the founding of the People's Republic of China, a series of important measures have been taken to reform and improve the old medical educational system.

First, the government took over control of all higher medical educational institutions.

Second, in 1952 order to correct the unreasonable geographical distribution the medical schools were partly relocated, some of them being moved from the large cities into the inland towns. For example, the Tung-chi (Tongji) University Medical School run by the Germans in Shanghai was moved to Wuhan and merged into the Wuhan Medical College.

Third, some new medical schools were established in remote provinces and autonomous regions with the help of medical schools which were strongly staffed and better equipped. For example, with the help of Shanghai First Medical College and the Shenyang Medical College the Xinjiang Medical College was established.

Fourth, unified directions for the specialities, the curriculum, the entrance examinations and so on were issued by the government in 1954. Senior teachers from different medical colleges were organized to write textbooks.

Fifth, the principle of integrating Chinese medicine with western medicine was introduced. In medical college, the courses of traditional Chinese medicine take about 10% of the clinical teaching hours. In addition, 25 traditional Chinese medical colleges have been established since 1956. In these schools about 500 hours are used to teach modern western medicine.

Sixth, secondary and primary medical education has been developed for training of health workers. The secondary medical schools accept junior middle school graduates and offer a three-year courses. To provide health care in the countryside, training of part-time health personnel was begun in 1965. These trainees are known as "barefoot doctors".



What should be pointed out is that during the "cultural revolution" starting from 1966 medical education suffered a great deal too. For medical schools were forced to stop admitting new students. When enrollment recommenced in 1970, the length of schooling was cut down to three years and the level of entrance lowered to junior middle school graduates. This abnormal phenomenon remained uncorrected until 1977.

China has now 116 medical schools and colleges of higher learning, of which 112 are independent. Most of these schools offer a five-year course covering medicine, public health, oral medicine, pediatrics and traditional Chinese medicine, and one offers an eight-year course. A four-year course is given in pharmacy and herbal medicine. The total number of graduates since liberation is more than 415,000.

There are 556 secondary medical schools, offering courses in medicine, traditional Chinese medicine, public health, maternity and child health, dentistry, radiology, nursing, midwifery, pharmacy and laboratory technology. The number of graduates exceeded 940,000 since 1949.

Today, China has about 1,396,000 barefoot doctors in the rural districts, averaging two per production brigade, and about 2,590,000 production teams health workers.

Hereafter, China, in the author's opinion, should follow the principle of combining popularization with the raising standards of medical education, i.e., stressing both quantity and quality.

Concentrating effort to run well the key medical colleges. Of the 116 medical schools six are the key medical colleges under the direct jurisdiction of the Ministry of Health. These colleges have priority in equipment, funds and most important, in teaching personnel, and enjoy preference in allocation of outstanding medical graduates and postgraduates. Efforts should be made to run well these medical schools.

Speeding up postgraduate training. Most medical colleges and medical research institutes should offer postgraduate training, and in those key medical colleges the ratio between postgraduates and undergraduates should be gradually increased.

Actively developing secondary medical education. In our country, there is a disproportion between senior and middle grade medical personnel. In many research institutes, the number of laboratory technicians is less than that of researchers, and in many hospitals doctors outnumber nurses. As a result many research workers have to do technician's work and doctors do the nurse's work. This is a big waste. We ought to have more secondary medical schools and each school, if possible, should enrol more students.

Training of barefoot doctors. We have 1,390,000 barefoot doctors. Short refresher courses should be given them from time to time, and we hope by 1985 about one third of the barefoot doctors will be equal in standard to secondary medical school graduates.

Aerodynamics

AUTHOR: HUANG Mingke [7806 2494 1870]

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TITLE: "A Fast Algorithm of the Finite Difference Method for Computation of the Transonic Flow Past an Arbitrary Airfoil with the Conservative Full-Potential Equation"

SOURCE: Mianyang KONGQIDONGLIXUE XUEBAO [ACTA AERODYNAMICA SINICA] in Chinese No 2, 1984 pp 19-24

TEXT OF ENGLISH ABSTRACT: Based on the methods developed by Jameson and Holst, a computer program has been developed for computation of the transonic flow past an arbitrary airfoil by the finite difference method. A conformal mapping is applied to map the exterior of the airfoil onto the interior of a circle. By a radical transformation reducing the effects of the singularity at the center of the circle, the use of the perturbation velocity potential is avoided. The governing equation simpler than those used by Jameson and Holst is approximated by a finite difference equation, which is then solved by AF2 iteration scheme in computing plane. The computations of the pressure distribution over the airfoil of NACA 0012 for subcritical and supercritical cases show the results in excellent agreement with those by Holst's method.

## Aerodynamics

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TITLE: "A Mixed Finite Difference Analysis of the Internal and External  
Transonic Flow Fields of Inlets with Centerbody"

SOURCE: Mianyang KONGQIDONGLIXUE XUEBAO [ACTA AERODYNAMICA SINICA] in Chinese  
No 2, 1984 pp 25-34

TEXT OF ENGLISH ABSTRACT: A mixed finite difference method for calculating the external and internal flow field around inlet with centerbody is presented. First, calculation by mixed finite difference method of the velocity potential equation with small disturbance in the transverse direction using cartesian mesh, irrotational schemes and exact body surface boundary conditions is carried out to obtain a basic field solution including the shape and location of the shock and the sonic line. Then, the full potential equation is used to improve the accuracy of the computed value of field variables. The use of multi-layer line relaxations along the radial lines is effective for inlet with centerbody, and in this case, more relaxation sweeps are carried out (with smaller relaxation factor) inside the inlet than outside. Computations have been made for axisymmetric inlet with different freestream Mach numbers  $M_\infty = 1.04 \sim 1.27$ . Computation results show that the method is promising.

## Aerodynamics

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TITLE: "Finite Difference Method for Solving Turbulent Boundary Layer Equations"

SOURCE: Mianyang KONGQIDONGLIXUE XUEBAO [ACTA AERODYNAMICA SINICA] in Chinese  
No 2, 1984 pp 41-49

TEXT OF ENGLISH ABSTRACT: This report presents a method for numerically solving laminar, transitional and turbulent compressible boundary layer equations for axisymmetric flows with a three-point implicit finite difference scheme. The turbulent boundary layer is treated with a two layer concept, and at each layer appropriate eddy viscosity models are used to represent Reynolds stress terms. In order to relate the turbulent heat flux term with the Reynolds stress the turbulent Prandtl number is assumed to be a constant. The system of governing equations is solved with an iteration method. For several situations presented in this paper satisfactory results are obtained using an improved eddy viscosity model and a smooth method of the eddy viscosity distribution.

## Aerodynamics

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TITLE: "A Study for Calculating Rotor Loads Using Free Vortex Concept"

SOURCE: Mianyang KONGQIDONGLIXUE XUEBAO [ACTA AERODYNAMICA SINICA] in Chinese  
No 2, 1984 pp 50-60

TEXT OF ENGLISH ABSTRACT: A rotor discrete free wake geometry and the blade airloads at each instant are presented. Based on the three dimensional classical theory of incompressible fluid, all have been obtained through a procedure of step-by-step iteration through a process similar to the start-up of a rotor in a free stream (i.e., the rotor is static when  $t=0$ , and it starts rotating at a constant angular speed  $\Omega$  and moves at a constant forward flight speed  $V_0$  with a time increment of  $\Delta t$ ). It is not until the wake has steadied down that the calculating can come to a stop. After the steady vortex wake has been obtained, the wake-induced downwash on each point interested and on the rotor can be computed. As a result, by using the theory of the thin airfoil and an approximate formula for lift and drag coefficient resulting for experimentation, suitable for the overall range of angle of attack that the blades would encounter when operating, we can get the blades' airloads and their responses.

A comparison of the first four harmonics airloads resulting from calculation with the correspondent loads obtained from flight test shows that their tendency, varying with the blade radius, has good agreement and there is an acceptable difference in their quantities.

Aerodynamics

AUTHOR: HUA Wei [5478 1218]

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TITLE: "Experimental Investigation of Heat Transfer to Bluff Cylinders and Cones in Hypersonic Rarefied Gas Flow"

SOURCE: Mianyang KONGQIDONGLIXUE XUEBAO [ACTA AERODYNAMICA SINICA] in Chinese No 2, 1984 pp 61-65

TEXT OF ENGLISH ABSTRACT: The report presents an experimental investigation of the heat transfer to bluff cylinders and sharp 10-deg half-angle cone at an angle of attack of  $0^\circ$ . The study was conducted in the low-density, hypersonic wind tunnel. Stagnation point and surface heat transfer data are obtained over a range of test conditions: Mach numbers at 12 and 24, unit Reynolds numbers from 1000 to 7000 per centimeter. The approximation formulae of the heat transfer are set up in rarefied transitional regimes. Comparisons are made to previously published experimental results and calculations from these approximation formulae.

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CSO: 4009/129

Chemistry

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TITLE: "Trace Determination of Tellurium in Natural Water by Voltammetry"

SOURCE: Changchun YINGYONG HUAXUE [CHINESE JOURNAL OF APPLIED CHEMISTRY]  
in Chinese No 2, Mar 84 pp 42-47

TEXT OF ENGLISH ABSTRACT: Trace tellurium has been determined by the anodic stripping voltammetry on a gold plated electrode or on a gold film deposited on a glassy graphite electrode. Sensitivity, accuracy of the method, recovery ratio as well as the influence of the interfering coexisting elements are discussed. The sample was previously separated and adsorbed through sulfhydryl cotton fiber. In 0.1M perchloric acid medium, the amount of tellurium in the water of the Min River and in the East Sea has been determined to be 8.1 and 1.8 ng/l, respectively, with the recovery error less than 10 percent.

9717  
CSO: 4009/91

## Radiation Protection

AUTHORS: Jin Naiyang [7246 0035 5391], Yan Kezhi [7051 0344 2535],  
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ORG: All of Institute of Atomic Energy

TITLE: "Study of Incorporating Organic Wastes Into Polystyrene"

SOURCE: Taiyuan FUSHE FANGHU [RADIATION PROTECTION] in Chinese Vol 4,  
No 2, 10 Mar 84 pp 106-116

ABSTRACT: This was a feasibility study to use styrene as the solidifying agent to process waste solvents and spent ion exchange resins from nuclear fuel processing plants and nuclear power stations through polymerization. The experimental work was divided into three stages: (1) identifying the conditions under which styrene monomers could be polymerized; (2) studying the solidification process with simulated materials; and (3) conducting hot experiments with actual spent solvents and waste resins contaminated by  $^{134}\text{Cs}$ . CHN-301 was chosen as the initiating agent and diethylene benzene was the crosslinking agent. The proper condition for low temperature, ambient pressure operation was determined. Pre-polymerization could be completed in four hours and solidification could be achieved in 6 hours. The optimum incorporation ratio was 3:5 for TBP and TBP-kerosene, and 1:1 for spent resins. It was proven feasible to treat spent solvents with styrene using a mixture of cement and asbestos powder as the absorbent. The solid had a leaching rate of  $10^{-6} - 10^{-7}$  cm/d, cumulative leaching fraction  $5 \times 10^{-4}$  cm, and volume reduction ratio 0.40 - 0.43, as well as good mechanical properties, radiation resistance, heat resistance, and combustion resistance. It was also feasible to directly solidify spent ion exchange resins. The leaching rate was  $10^{-6}$  cm/d, cumulative leaching fraction was below  $4 \times 10^{-4}$  cm, yield strength was above 180 kg/cm<sup>2</sup>, and drop height without damage was 9 m. These two products could satisfy the requirements for long distance transportation and safe storage. This work received the guidance of comrades Wang Dexi [3076 1795 3556] and Yu Chengze [0060 2110 3419] and assistance from the polymer teaching and research offices of Qinghua University and Beijing Chemical Engineering Institute. Comrades Jin Huimin [6855 8396 3046], Sun Guixin [1327 6311 0207], Xu Yongyuan [1776 3057 3293] et al., assisted in various tests. The manuscript was received on 27 Dec 82.

12553

CSO: 4009/85



## Radiation Protection

AUTHORS: Atmospheric Diffusion Experiment Group

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TITLE: "Atmospheric Diffusion in Hilly Region on Middle Reaches of the Chang Jiang"

SOURCE: Taiyuan FUSHE FANG [RADIATION PROTECTION] in Chinese Vol 4, No 2, 10 Mar 84, pp 81-89

ABSTRACT: An atmospheric diffusion test was conducted in a hilly region on the middle reaches of the Chang Jiang (see Figure 1) from June 79 to Dec 80. The purpose was to explore an atmospheric diffusion model and to study the effect of terrain and release height on diffusion parameters. A 102-meter-high tower was erected and divided into 10 levels. Various instruments were installed on the tower (see Table 1) to measure wind speed, direction and fluctuation, temperature profile, and humidity. In addition, four ground meteorological stations were also set up for routine observation. Vertical diffusion parameters were obtained using smoke photography.  $\text{SF}_6$ ,  $\text{CF}_2\text{ClBr}$ , and fluorescent sodium dye aerosol were used as tracers and released simultaneously from 48, 75, and 102 meters to study the horizontal diffusion characteristics and the effect of release height on the horizontal diffusion parameter  $\sigma_y$ . Results of meteorological observations were presented. The smoke column was conical under certain weather conditions, reflecting the effect of roughness in a hilly area where the turbulent vertical diffusion parameter is larger than that in a plain region. The horizontal diffusion parameter  $\sigma_y$  decreased with increasing release height under the same weather condition at the same location. This is because the intensity of the mechanical turbulence caused by the rough terrain decreases with height. The Lagrangian-Euler time scale ratio  $\beta$  was 3.7 which is lower than that in a plain region. The mean annual diffusion factor deviated from the calculated based on the P-G curve due to the rough terrain. The Gaussian diffusion model must be modified by taking the terrain into consideration. The major participants of this work included Chen Zhuzhou [7115 4554 5297], Hu Erbang [5170 0059 6721], Wang Shoushu [3769 1343 1859], et al. Chen and Hu were the actual authors and Zhang Yongxing [1728 3057 5281] of the Institute of Atomic Energy provided technical guidance. The authors also expressed their gratitude to Professor Li Deping [2621 1725 1627] for his guidance as well as Zhong Aichen [1728 7224 3819], Ye Wenhui [0673 2429 5706] and Chen Jiayi [7115 1367 1355] of Beijing University for their assistance. The manuscript was received on 27 Oct 82.

Table 1. Distribution of Instruments on the Tower

<u>Level</u>	<u>Height</u>	anemometers**				temperature sensor*	
		<u>model 75M-1</u>	<u>model EL-2</u>	<u>model EL</u>	<u>bivane</u>	<u>transistor</u>	<u>thermocouple</u>
1	2.6	yes	yes			yes	yes
2	6.0					yes	yes
3	10.0	yes	yes		yes	yes	yes
4	18.0					yes	yes
5	34.0	yes	yes			yes	yes
6	48.0					yes	yes
7	61.0	yes	yes			yes	yes
8	75.0			yes	yes	yes	yes
9	88.0					yes	yes
10	102.0	yes	yes			yes	yes

\* homemade instrument, accuracy 0.1°C.

\*\* Starting wind speeds are approximately 0.5-0.7 m/sec, 1.0 m/sec, and 0.7 m/sec for Models 75M-1, EL-2, and EL, respectively.

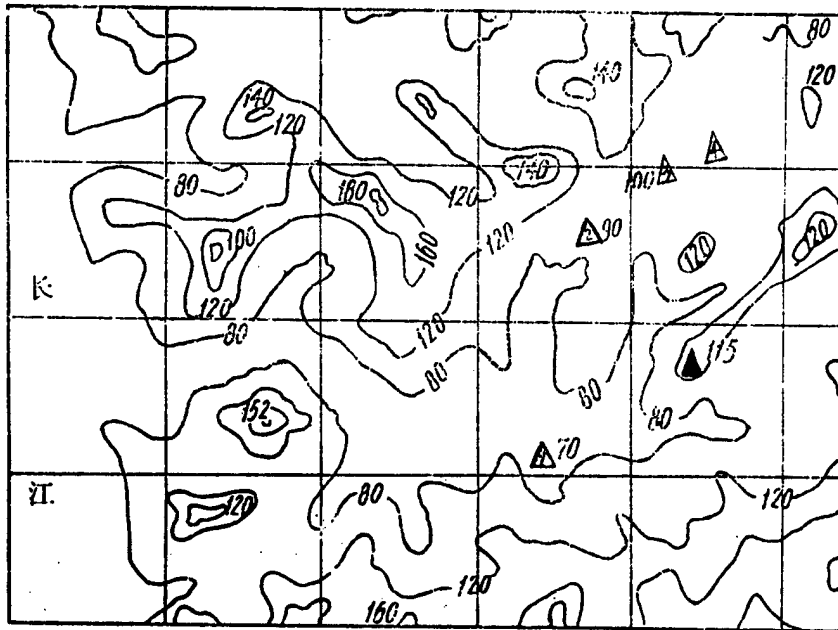


Figure 1. Experiment Site Terrain (1:25,000)

△1, △2, △3, △4 are the ground observation stations and ▲ is the tower.

12553

CSO: 4009/85

## Silicates

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TITLE: "Thermoelectric Power and DC Conductivity of Bulk As-Te Chalcogenide Glasses"

SOURCE: Beijing GUI SUANYAN XUEBAO [JOURNAL OF THE CHINESE SILICATE SOCIETY]  
in Chinese No 1, Mar 84 pp 48-52

TEXT OF ENGLISH ABSTRACT: Thermoelectric power and DC conductivity of bulk As-Te, As-Te-Ge and  $(\text{As}_2\text{Te}_3)_{1-x}\text{Ni}_x$  chalcogenide glasses as functions of temperature have been studied. The experimental results show that over a wide temperature range, the conductivity activation energy  $E_G$  is larger than the activation energy  $E_A$  (from plot of thermoelectric power versus reciprocal temperature), and the difference between  $E_G$  and  $E_A$  is of the order of 0.15~0.2 eV. The results indicate weaker temperature dependence of thermoelectric power when compared with conductivity. The conduction mechanism may be explained by a two-channel model with transport simultaneously in both extended and band-tail-localized states. Hopping conduction near the Fermi energy has been observed in low temperature range. For bulk  $(\text{As}_2\text{Te}_3)_{1-x}\text{Ni}_x$ , experimental results show that effects of Ni on conductivity are smaller and thermoelectric power decreases with increase of Ni content.

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CSO: 4009/90

END